DIRECT TESTIMONY OF

ERIC H. BELL, P.E.

ON BEHALF OF

DOMINION ENERGY SOUTH CAROLINA, INC.

DOCKET NO. 2021-88-E

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND OCCUPATION.

A. My name is Eric H. Bell. My business address is 220 Operation Way, Cayce, South Carolina. I am employed by Dominion Energy Services, Inc. as the Manager-Electric Market Operations for Dominion Energy South Carolina, Inc. ("DESC" or the "Company").

Q. STATE BRIEFLY YOUR EDUCATION, BACKGROUND, AND EXPERIENCE.

A. I am a graduate of the University of Texas at Austin with a Bachelor of Science degree in Electrical Engineering and am licensed in South Carolina as a Professional Engineer. Following graduation, I served in the United States Navy as a Nuclear Submarine Officer. In 1994, I began my career with South Carolina Electric & Gas Company ("SCE&G") as Assistant Plant Engineer and, in 1997, was promoted to Operations Planner. From 2001 to 2008, I engaged in economic resource commitment efforts and, in 2008, I assumed my current role as Manager – Electric Market Operations. In this position I manage a group of Economic Resource Commitment Planners and am responsible for managing and optimizing generation fleet dispatch and unit commitment to provide reliable, low-cost energy to DESC customers. Among other things, my responsibilities include participating in fuel purchasing decisions, unit commitment, and the coordination of activities and system cost data with power marketing, transmission system control, maintenance scheduling, and natural gas supply. Since June of 2019, I have also been responsible for DESC's generation planning, which includes managing the development of the Integrated Resource Plan ("IRP"), avoided cost studies, and other applications for long-term portfolio and production cost modeling.

Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT WITNESS BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA ("COMMISSION")?

A. Yes, I have testified before in prior proceedings, including avoided cost matters.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I discuss the following topics in my testimony:

(1) The actual operational experience of the Company related to the additional costs that result from managing the energy supplied by photovoltaic solar generation facilities interconnected with DESC's system.

(2) The reference data and other inputs from this operational experience that the Company provided to Guidehouse Consulting, Inc. ("Guidehouse") in connection with the solar generation Variable Integration Cost ("VIC") study ("Guidehouse Study") being sponsored by Company Witness Peter David. In this context,

a. I discuss the Company's review of the Guidehouse Study; and

b. I explain the application of the VIC in the PR-1 Solar and PR Standard Offer Solar rates, which apply to solar facilities equal to or less than 2 MW.

(3) The Time-of-Production Avoided Cost Schedule ("TOP Schedule"), which applies to qualifying facilities equal to or less than 2 MW that have generation characteristics significantly different from a phototvoltaic[1] solar-only electric generator. Furthermore,

[1] All of the solar generators present and expected on DESC's system are photovoltaic and all following solar references refer to photovoltaic systems.

a. I support the continued application of the Solar rates for Rate PR-1 and Rate PR-Standard Offer for projects having characteristics similar to a standalone solar-only electric generation facility;

b. I explain why the TOP Schedule is applicable for all other types of generation and combinations of QF generator types, and why the TOP Schedule provides an accurate value benefitting our customers; and

c. I explain that additional system resources could mitigate or reduce the VIC.

(4) Finally, I introduce the Energy Exemplar PLEXOS model that was used in the preparation of the avoided costs submitted by DESC in this docket.

<u>OPERATIONAL EXPERIENCE WITH SOLAR FACILITIES</u>

Q. DO SOLAR FACILITIES PRODUCE ELECTRICITY INDEPENDENTLY OF CUSTOMERS' DEMAND FOR ENERGY?

A. Yes. Because solar panels convert light directly into electricity, the electrical power output of each facility is dictated not by customer demand or system dispatching but by the amount of sunlight on the panels. In general, solar facilities begin producing some energy just after sunrise, after which the output increases for about two or three hours before reaching a level that, depending upon cloud cover and weather factors, falls anywhere in a range from less than 10% to 100% of rated capability. In addition to the more predictable generation ramps at the beginning and the end of the day, unpredictable minute-to-minute variability occurs throughout the day based on the time of day and local weather conditions. In short, it is completely unavoidable that the sun provides energy during a limited number of hours, that the solar panel output is not driven by customer demand or system need, and that the electrical generation output from solar facilities during daylight hours will drop unexpectedly, return unexpectedly, or remain low unexpectedly.

Q. ARE YOU IN A POSITION TO VISUALLY DEMONSTRATE THE VARIABILITY OF UTILITY-SCALE SOLAR GENERATION?

A. Yes. This variability is demonstrated in Charts 1 through 8 below, which show actual examples of production profiles of the aggregated output of utility-scale solar generation on DESC's system on certain days during 2020 and 2021. These charts show situations that occur regularly throughout the year with respect to solar generation and system load. Each chart contains a display of one-minute or five-minute data for 24 hours on the actual day noted on the chart. The chart scale on the left axis is in megawatts. Notice that the maximum solar generation that was in service for production changes over time.

Each chart displays three sets of data: system load; utility-scale solar aggregated power output; and the net load, which is the difference between the first two data sets and represents the load that is served by other generation. The system load curve (black line) is composed of one-minute data and represents the usage of all customers within the DESC service territory and Balancing Authority Area ("BAA"). Dispatchable generation (non-solar) supplies net load (blue line) along with operational reserves and allows System Control to balance the production and usage within the BAA. The green line represents the aggregated power output of utility scale solar facilities under contract with DESC. Each chart is used to illustrate some of the benefits and challenges that solar generation provides during various situations.

Summary of Charts

Chart 1 shows that solar power contributes during high value hours in the warmer months, but that additional solar generation does not reduce net peak demand. Chart 2 shows that solar power does not serve the peak demand period on cold winter days and additional solar will contribute only in the lowest value hours on the coldest days. Chart 3 is an example of a large and unexpected drop in solar power output with dispatchable generation picking up over 50% of solar power output. Charts 4 through 7 depict an example of severely limited solar output that continues for several days in a row. Chart 8 illustrates that additional solar generation will contribute only the very lowest value hours on low load days.

Chart 1

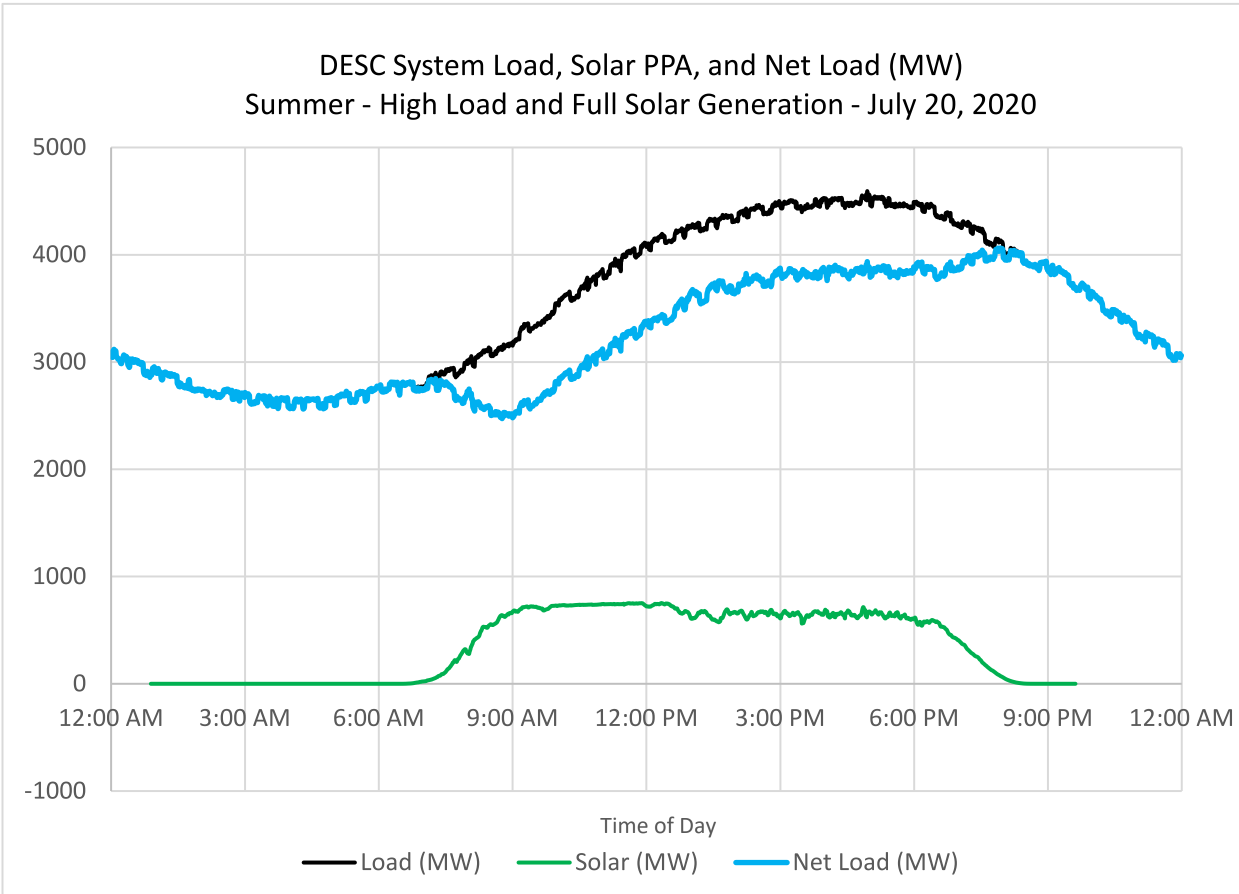


Chart 1 shows data from a hot and sunny summer day with high levels of production from over 790 MW of utility-scale solar generation facilities. Starting at about 7 a.m., solar generation can approach full output in less than three hours, which is fairly characterized as an uncontrolled ramp. It is fair to note that except in the first two hours of the day, the solar generation is a good fit with system energy needs on warm summer days. However, additional reserves must be carried in the form of some other type of generation in the event that some of the 790 MW of solar generation drops unexpectedly at any point in the day.

Chart 2

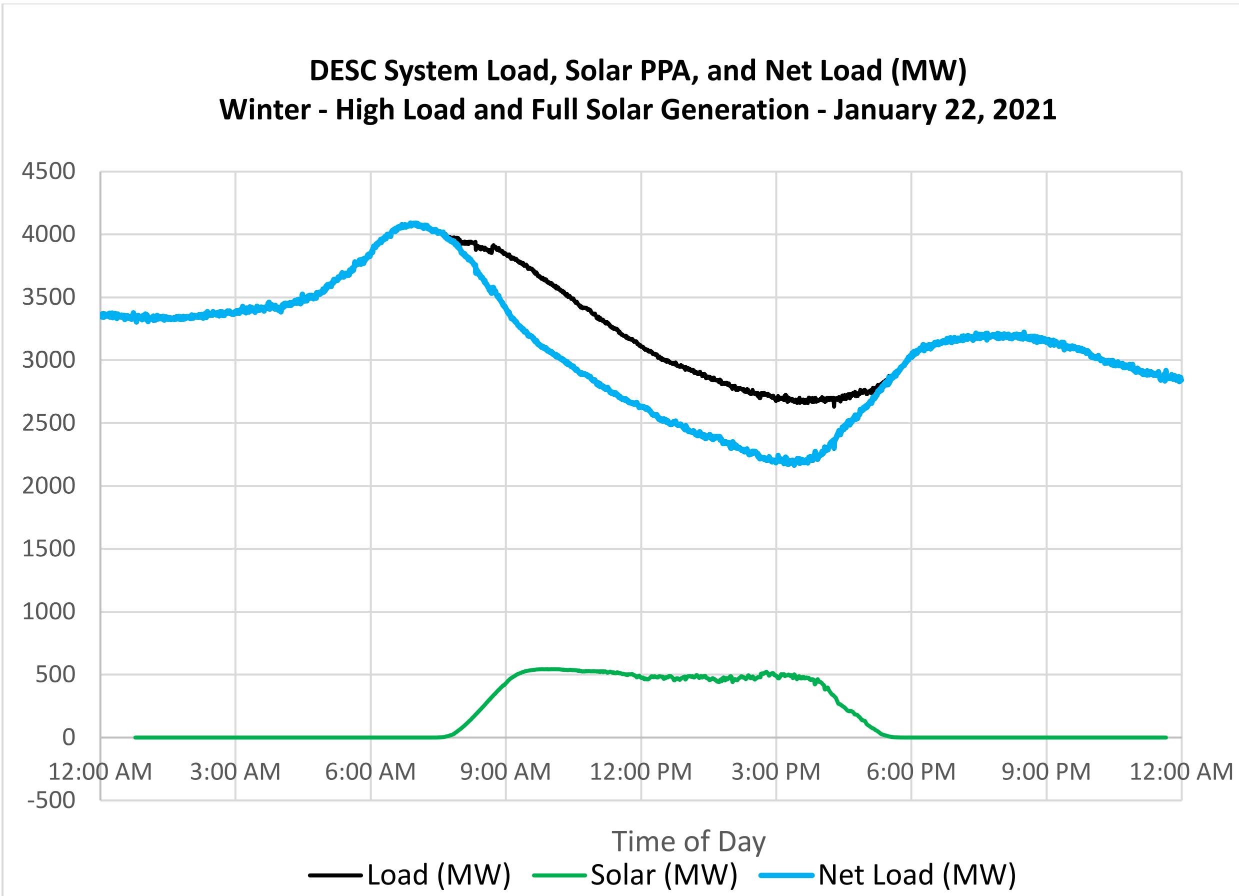


Chart 2 displays data from a high production day in the winter with a more aggressive ramping of generation. None of the solar generation was produced in the peak period at around 7 a.m. Solar generation displaces higher value generation throughout the morning after the peak. It produces energy at the same rate after 11 a.m. during the lowest value hours of this day. This is not to say that the solar energy is without value, but this curve informs the results of the avoided cost calculations that include these lower value hours. By two hours into the evening load ramp and additional high value hours, solar output has dropped to zero.

Chart 3

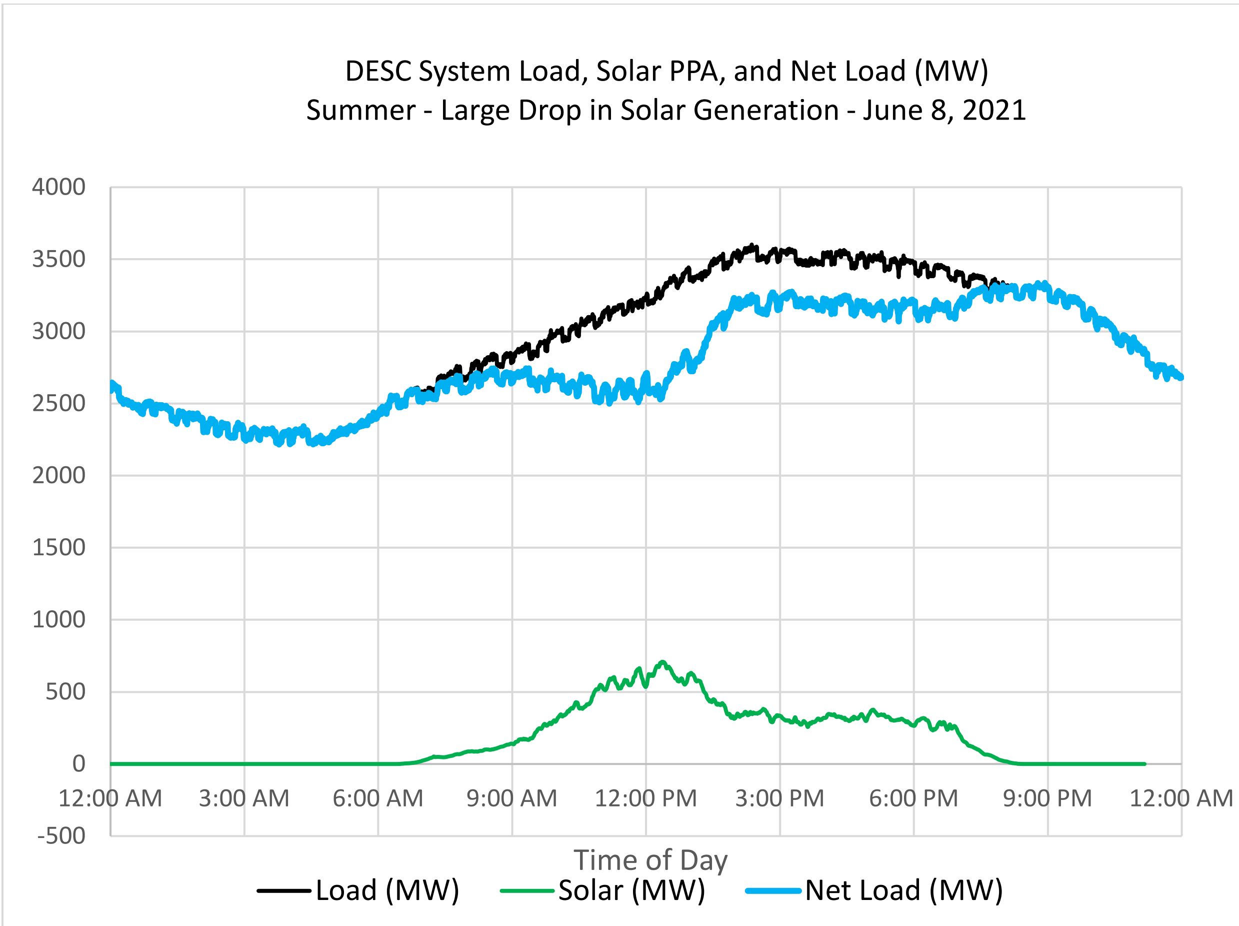


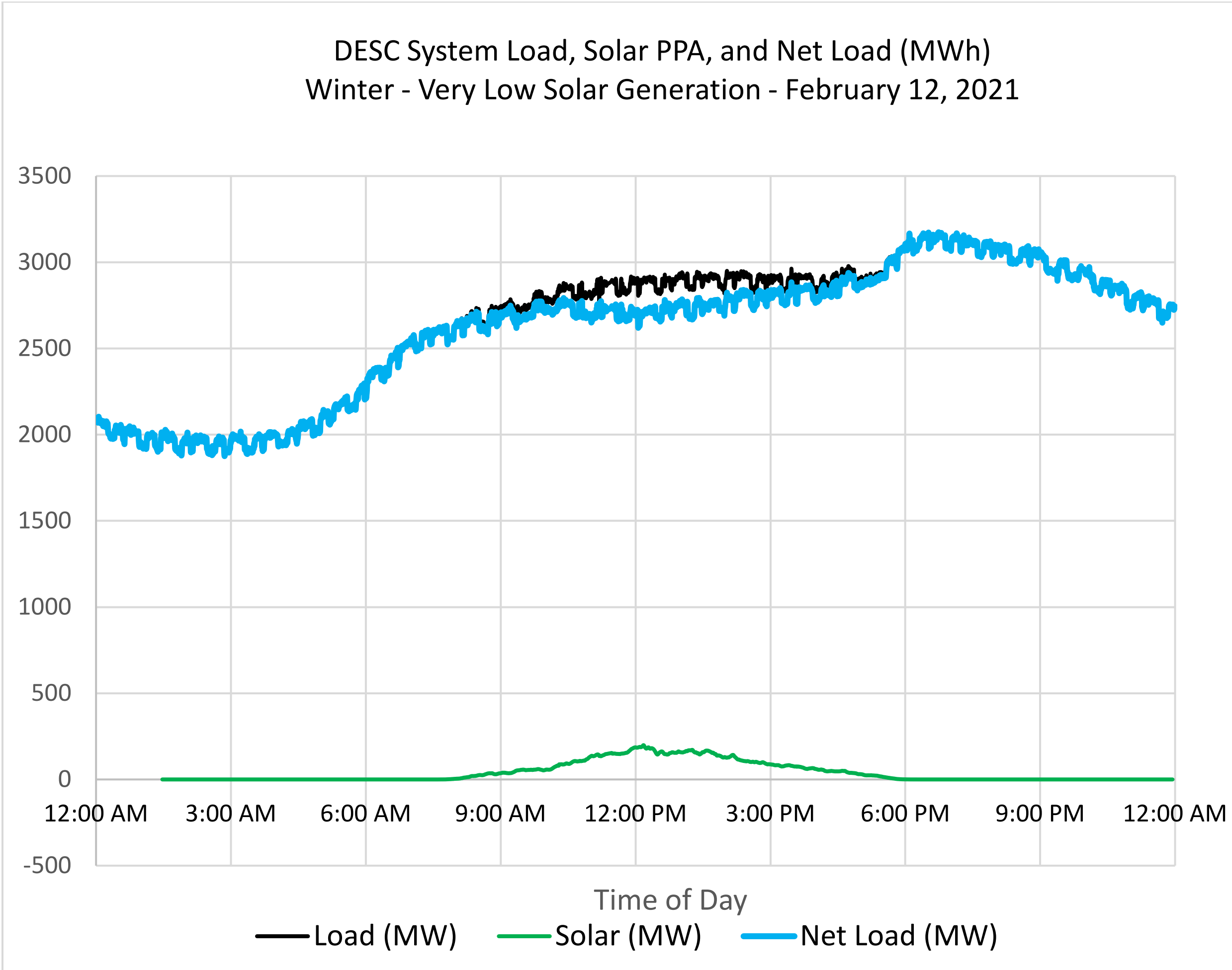
Chart 3 shows the system load and solar output on a recent summer day where the utility-scale solar output drops from 708 MW at about 12:20 P.M. to 315 MW by 2:15 P.M. This illustrates the actual conditions that require DESC to have additional regulating and operating reserves. When the solar generation output drops unpredictably, customers continue to use energy and require reliable service that can only be provided by firm generating resources managed by the Balancing Authority. The sharp midday increase in net load shows how much generation that

DESC held in a standby condition in addition to maintaining the required contingency reserves.

Charts 4 - 7

Charts 4 through 7 show load and solar generation on four days in a row in February of 2021. These days would be unremarkable other than the very low solar generation that occurred on each of these successive days due to weather conditions. Instead, these days illustrate the need for a solution to the limited nature of solar energy supply that must be solved before a solar-based renewable energy future can be realized.

Chart 4



In Chart 4, the 898 MW of utility-scale solar facilities on line on that date are able to produce 153 MW for a short time and generate 818 MWh for the day due to weather conditions. This represents an output of about 25% of the daily average from December 1, 2020, to February 28, 2021. It is extremely important to realize that these 898 MW of solar facilities that can produce 6400 MWh on a summer day can be severely limited on certain days – generating only about 7% of what would be expected other times of the year.

Chart 5

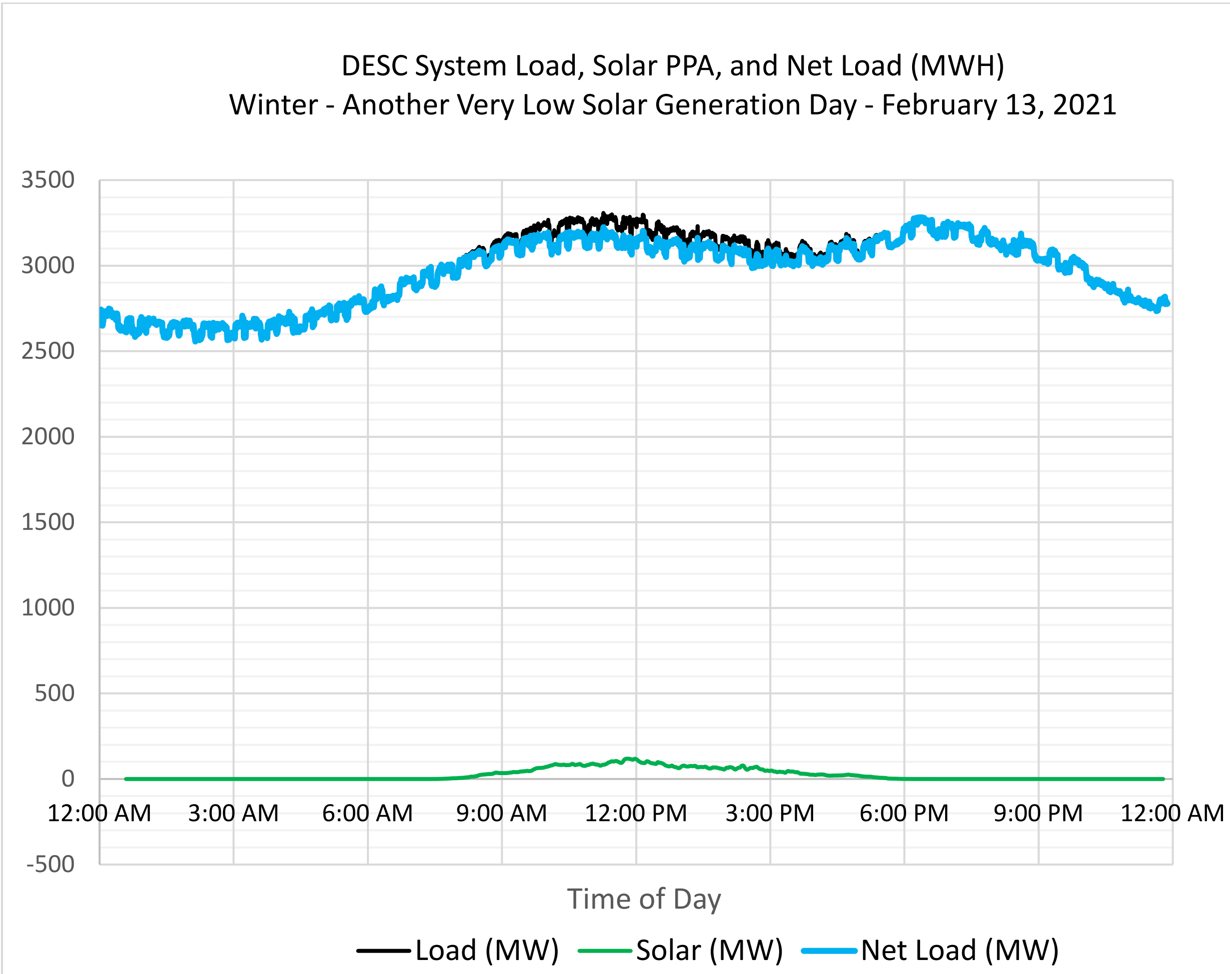


Chart 5 shows the system load, solar generation, and net load for February 13, 2021, which is the day following the day shown in Chart 4. This day also yielded very low solar energy production. In Chart 5, the approximately 898 MW of utility-scale solar facilities on line on that date were able to produce 91 MW for a short time and generate 499 MWh for the day due to weather conditions, which is actually lower output than the prior day. This represents an output of about 15% of the daily average from December 1, 2020, to February 28, 2021.

Chart 6

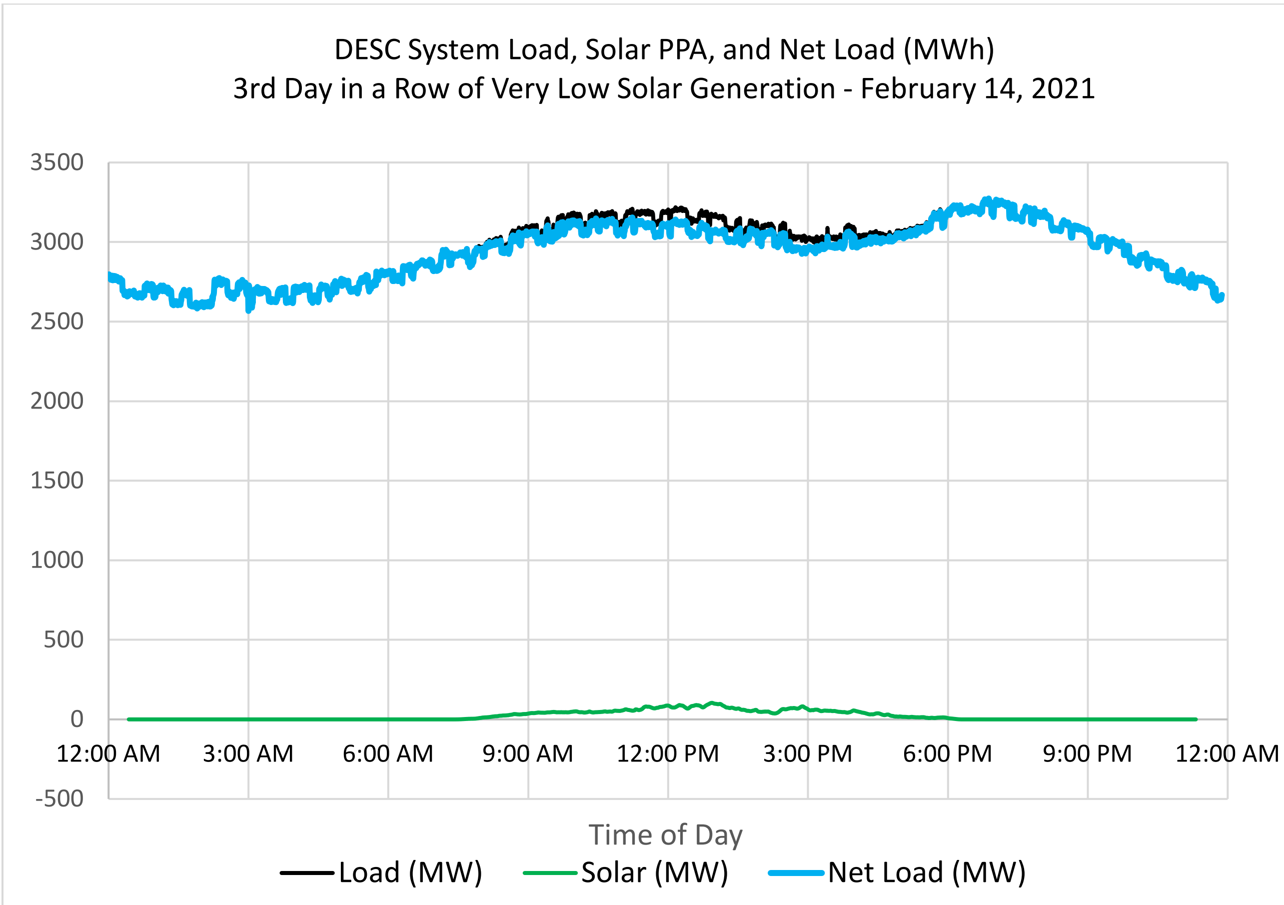


Chart 6 shows the system load, solar generation, and net load for the next day, February 14, 2021. This day again had very low solar energy production. In Chart 6, the approximately 898 MW of utility-scale solar facilities on line on that date were able to produce 77 MW for a short time and generate 463 MWh for the day due to weather conditions. This output is again less than the prior day and represents an output of about 14% of the daily average from December 1, 2020, to

February 28, 2021. Over the three consecutive days shown in Charts 4, 5, and 6, solar supplied much less energy than forecasted and, on average, solar supplied very little of the energy consumed by DESC customers over the three days.

Chart 7

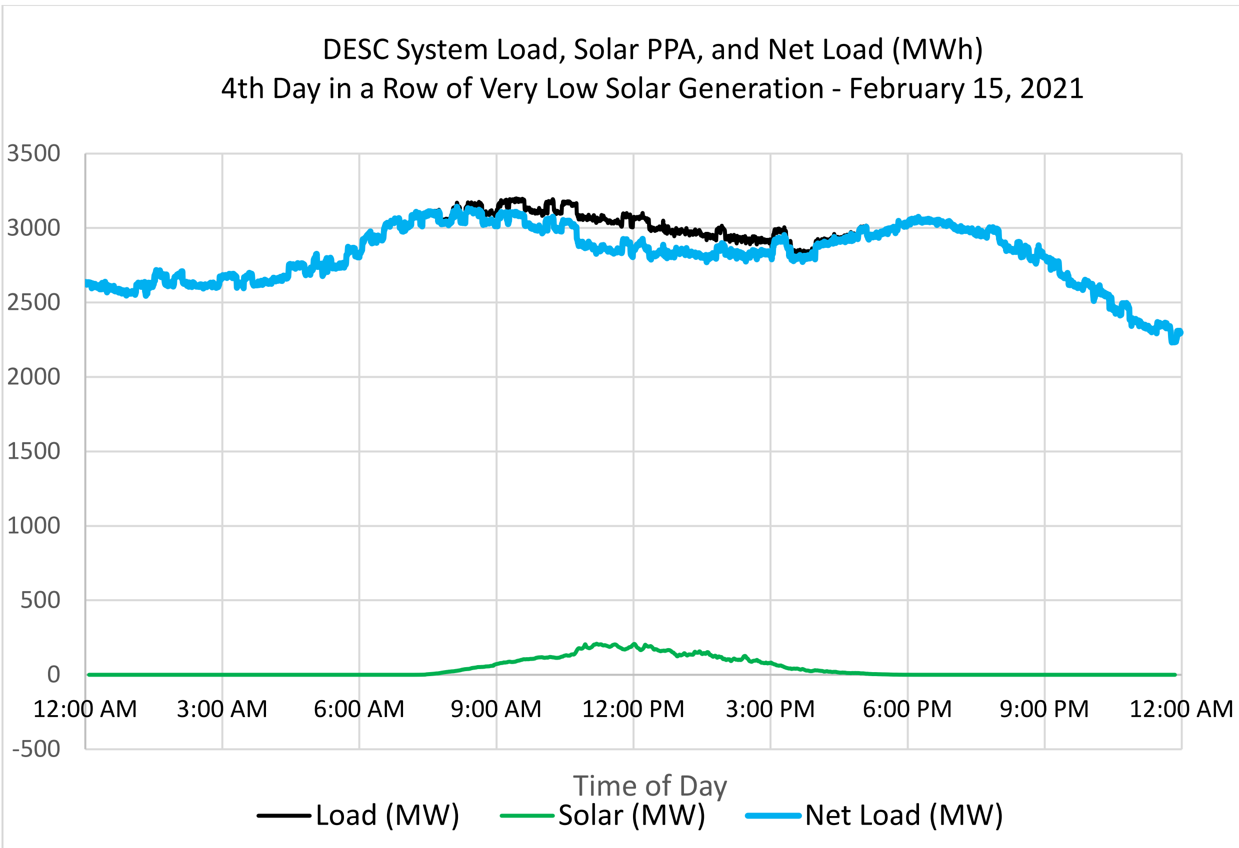


Chart 7 continues the series, showing the system load, solar generation, and net load for February 15, 2021, the day following the day shown in Chart 6. Again, this day had low solar energy production. In Chart 7, the approximately 885 MW of utility-scale solar facilities on line on that date were able to produce 176 MW for a short time and generated 881 MWh for the day due to weather, representing an output of about 21% of the daily average from December 1, 2020, to February 28, 2021.

Summary of Charts 4-7

During these four winter days, February 12-15, 2021, the DESC system load was 63,628 MWh; 71,748 MWh; 70,994 MWh; and 68,454 MWh each day. Of this 274,824 MWh of total customer usage on these four consecutive days, utility-scale solar facilities supplied 2,661 MWh, constituting 1% of the load.

These four days represent an example of an infrequent but certain occurrence when operating with solar. More importantly, weather events like this occur almost every year and, when combined with lower temperatures and higher loads as is seen every few years, establish a design basis for the future reliable operation of electric grids. These charts do not quantify the avoided cost or reliability impact of solar, but certainly illustrate why the calculated value additional solar-only resources have a lower value component at times and that there is a clear need for a reliability-based resource plan that must account for a solar-limited design basis scenario. Studies of these four-to-seven-day weather events will show that a defined level of non-solar and non-storage resources will be absolutely necessary for reliable and compliant operations even with a renewable-based energy system.

Chart 8

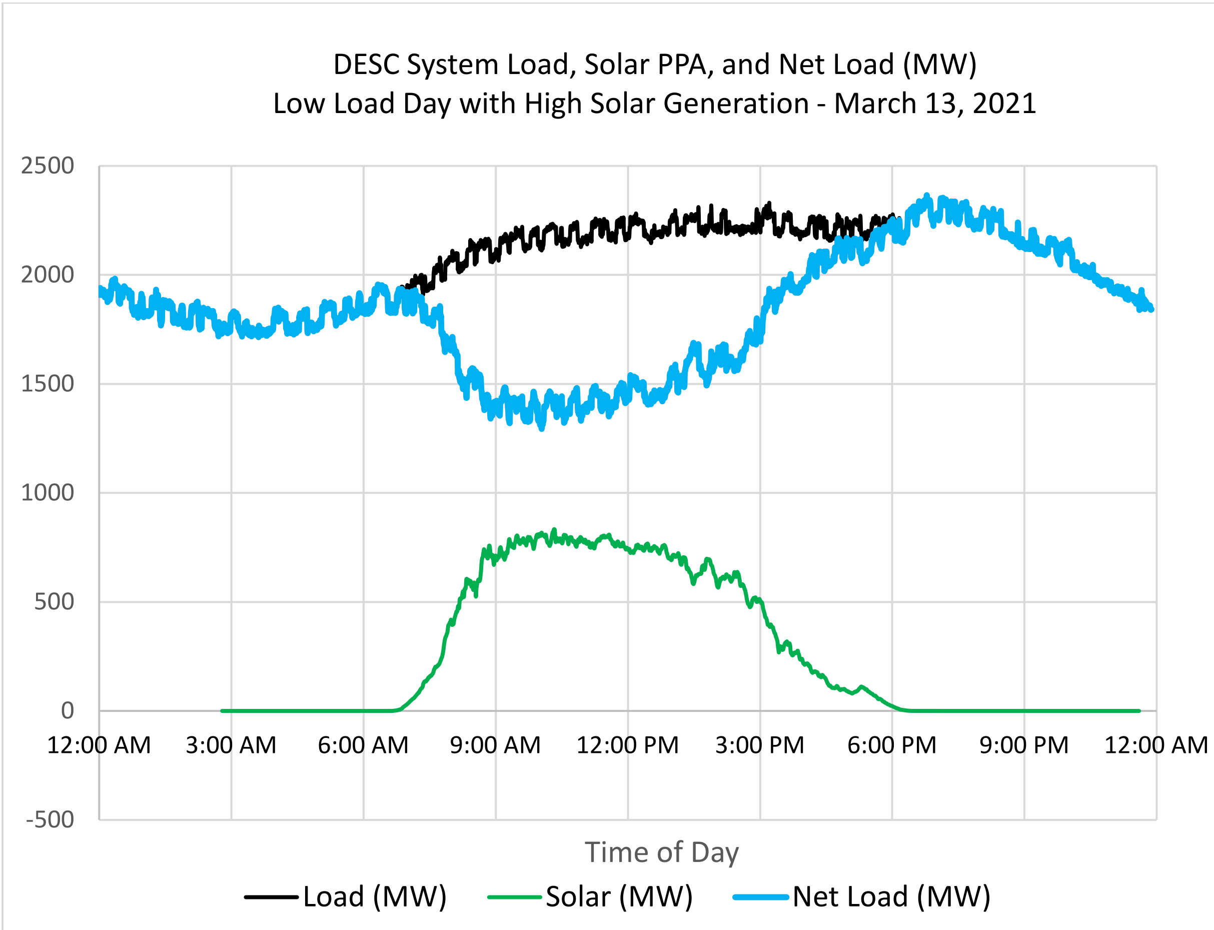


Chart 8 shows the system load, solar generation, and net load on March 13, 2021, a day that is one of the typically milder weather days during the winter months. The data for this date shows that net load and the non-solar resources needed to serve that load are already reduced by the existing solar facilities in daylight hours. Any additional solar facilities would have an extremely low avoided cost in the daylight hours of this day. This low value is exacerbated by the fact the existing and future solar-only resources would not contribute to the morning or evening peak demand periods and high value hours on days like this.

Q. WHAT IS THE COMPANY'S RECENT EXPERIENCE WITH RESPECT TO THE NUMBER OF SOLAR FACILITIES INTERCONNECTED WITH ITS SYSTEM?

A. In previous years, the Company has experienced a significant increase in generator interconnection interest. A 2 MW rooftop installation and an approximately 7 MW of Distributed Energy Resource utility-scale installation were the only utility-scale solar generators in the DESC service territory before 2017. By December 31, 2020, approximately 1,003.4 MW of solar generation was interconnected to the DESC system, including approximately 115.1 MW in "customer-scale" generation and 888.3 MW in "utility-scale" solar.

Q. DOES DESC EXPECT THAT ADDITIONAL UTILITY-SCALE SOLAR FACILITIES WILL BE INTERCONNECTED TO ITS SYSTEM IN THE NEAR FUTURE?

A. Yes. In addition to the facilities already interconnected and providing power to the DESC system, two more solar facilities have executed agreements with the Company to provide additional solar power to DESC's system. Each of these facilities is expected to enter commercial operation in 2022. When constructed and interconnected, these additional facilities will add approximately 148.57 MW of additional utility-scale solar generation to the Company's system, including an 18 MW energy storage system that is part of one of those projects. Following these interconnections, DESC expects to have a total of 1,046.44 MW of utility-scale solar facilities interconnected with its system by the end of 2022.

Q. ARE THERE INCREASING CHALLENGES IN RELIABLY MANAGING THE DESC SYSTEM WITH THE INCREASING NUMBER OF INTERMITTENT AND VARIABLE SOLAR FACILITIES?

A. Yes. As more intermittent solar is added and knowing that it cannot be precisely predicted or dispatched, DESC must plan for larger unexpected drops in solar output. Therefore, DESC must carry more additional reserves as solar only resources are added. In addition to the significant intermittency and variability of solar, PR-1 and PR Standard Offer solar-only electric generation is "must-take"; i.e., it must be added to the Company's system when it is generated. Normally, dispatchable generation using traditional generation assets is added in order of economic merit as the system load increases and is removed as the load decreases. By comparison, solar generation is a product of factors beyond the Company's or generation owner's control, such as available sunlight and cloud cover, and it responds not to system needs but to weather conditions.

Q. GIVEN THIS VARIABILITY, HOW DOES DESC PLAN FOR THE AMOUNT OF SOLAR GENERATION THAT IS PUT TO ITS SYSTEM ON A DAILY BASIS?

A. On a regular basis, both the solar generation owners and the Company forecast the expected amount of solar generation, considering anticipated weather conditions and the characteristics of the individual generating facilities. Because actual weather conditions can vary greatly from forecasts, projections of anticipated solar generation are much less accurate than those of other generating resources such as a natural gas or coal-fired generation facility. Some, but not all, of the forecasted solar generation can be predicted with reasonable certainty; however, when the amount of solar energy actually generated does not meet the forecasted projections, the shortfall must be supplied by generation from another resource. The Company must be ready for the unexpected loss of solar generation well ahead of the actual weather contingency.

Q. DOES FORECASTING ELIMINATE THE COMPANY'S NEED TO MAINTAIN RESERVES TO MEET THE LOSS OF SOLAR GENERATING CAPACITY ON ITS SYSTEM?

A. No. Although forecasting helps and is necessary, weather forecasts are not precise. Accordingly, because of the significant variability and intermittency of solar generation, DESC must make operational adjustments to follow the energy generated by solar facilities and to maintain sufficient reserve generation capability in order to meet system reliability requirements.

Q. ARE THERE CHALLENGES IN ENSURING THAT TRADITIONAL GENERATION ASSETS ARE AVAILABLE IN RESERVE TO MEET THE VARIABLE AND INTERMITTENT NATURE OF SOLAR GENERATION?

A. Yes. Traditional generation assets cannot begin generating electricity immediately but must be given adequate time to be brought online and respond when called upon to fulfill an unexpected shortfall. Although some types of smaller generators on DESC's system can start quickly from an offline standby condition, the amount of capacity they can supply is limited. DESC's larger generators must be brought on line well ahead of the contingency. It is the cost of this additional generation that is the basis for the VIC. Unlike the owners of solar generating facilities, DESC has an obligation to balance generation to load and maintain reserves at all times. That obligation is absolute and sometimes creates additional but necessary costs.

Q. IS THE COMPANY SUBJECT TO RESERVE REQUIREMENTS THAT WILL BE IMPACTED BY THE INEVITABLE LOSS OF SOLAR ENERGY?

A. Yes. In addition to maintaining reserves to fulfill the demands of its own customers, the Company is subject to requirements established by the North American Electric Reliability Corporation ("NERC") and the SERC Reliability Corporation. The Company also is a signatory to the VACAR (Virginia/Carolinas) Reserve Sharing Arrangement through which it maintains required reserve generation capability at all times in the event of a contingency—i.e., a reserve call from a neighboring utility or a sudden loss of generation such as when a generating facility is unable to generate electricity. When a VACAR reserve sharing partner calls upon reserves or a DESC generator experiences a sudden unplanned forced outage, reserve capability is being "used," and does not need to be reestablished immediately under the terms of the VACAR Reserve Sharing Arrangement. However, when the territorial load exceeds forecast or non-dispatchable solar generation is not producing the expected level of electric generation, DESC must ensure that other generation is producing power to meet load, while making other generation supply available to maintain the reserve requirement. Under these circumstances, DESC must have generators available or online that are capable of quickly and reliably producing electricity so any sudden shortfall can be met.

Q. HOW ARE CONTINGENCY RESERVES SUPPLIED?

A. Under VACAR, the Company must supply contingency reserves on demand within ten minutes. VACAR reserves include spinning and non-spinning reserve requirements. Spinning reserves are provided by generators that already are online but not operating at full capacity and therefore can immediately generate additional electricity to serve the load. Non-spinning reserves may be supplied by both online and offline generators that can be fully loaded within ten minutes and to some extent by interruptible contracts. The generators with the fastest response capability are fast start combustion turbines ("CTs"), certain hydropower facilities, and pumped storage generators ("Pumped Storage"). Economical operation of CTs normally has them offline in stand-by and supplying non-spinning reserve capability much like Saluda Hydro provides spinning and non-spinning reserves. In the future, both of those types of units will continue operating in the same way from the standby mode.

Q. HOW IS DESC ABLE TO INCREASE ITS AMOUNT OF AVAILABLE RESERVE CAPACITY?

A. The only way to increase reserves from CTs and Saluda Hydro is to construct additional units. Reserves from quick starts and Saluda Hydro have been fully utilized for years, and no additional reserve value can be gained from those existing units. While Pumped Storage does supply spinning and non-spinning reserves, the optimal operation of Pumped Storage is dictated by economical limitations. Creating additional reserves by holding back Pumped Storage adds fuel costs in most circumstances because the output from higher cost generating units must be increased. In addition, the Company can increase its reserves by operating more coal and gas-fired baseload units. However, doing so may require DESC to operate its natural gas or coal-fired generating facilities under low load conditions or at an output level that is less efficient—i.e., more costly—than the optimum level for which they were designed. Thus, there is a cost to operating the generating units that provide these higher reserve levels, and those costs increase as more reserves are required.

VIC STUDY BY GUIDEHOUSE

Q. DID THE COMPANY ENGAGE GUIDEHOUSE TO QUANTIFY THE OPERATIONAL COSTS OF MAINTAINING SUFFICIENT RESERVES TO OFFSET THE VARIABILITY AND INTERMITTENCY OF SOLAR GENERATION?

A. Yes. As is more fully explained and discussed by Company Witness David, DESC engaged Guidehouse to evaluate the operational and financial impact of serving DESC's customers with solar generation in addition to the Company-owned resources.

Q. DID DESC PROVIDE GUIDEHOUSE WITH OPERATIONAL DATA FROM THE COMPANY?

A. Yes. The Company provided Guidehouse with information concerning DESC's NERC/VACAR operating requirements, as well as input and reference data related to the solar generation facilities interconnected with DESC's system. The Company also provided Guidehouse with forecasts and the current resource plan showing the need for additional capacity during the next fifteen years and identifying, on a preliminary basis, whether the need is for summer or winter capacity. DESC also provided Guidehouse with the Company's peak seasonal demand, energy sales, and self-owned generation portfolio, as well as information concerning generator characteristics, including size in megawatts, fuel cost, efficiency, and operating flexibility. This information is included in the Company's Modified 2020 Integrated Resource Plan filed on February 19, 2021, in Docket No. 2019-226-E, which I incorporate herein by reference, and provides an accurate representation of the Company's dispatchable electric supply. Finally, the Company provided information concerning actual solar generation profiles from existing projects, existing solar PPAs, forward fuel prices, and natural gas pipeline contracts.

Q. DID THIS INFORMATION INCLUDE PROFILES OF SOLAR FACILITIES INTERCONNECTED WITH DESC'S SYSTEM?

A. Yes. The Company provided Guidehouse with hourly solar energy profiles from actual solar installations with energy production in the DESC service territory. On the DESC system, the solar generation energy production profile is dominated by the utility scale single-axis tracker with panel capability in excess of the plant rating and inverter capability. On sunny days, this generating profile sharply increases from sunrise to nearly full load electrical output in less than two to three hours. solar output then stays at or near full load until about two to three hours before sunset unless there is cloud cover. On partly cloudy days, the profile is extremely volatile and much less predictable. Cloudy days result in expectedly low generation output. Although this relationship is conceptually simple, the partly cloudy and cloudy days are the most difficult to forecast and can cause large deviations from the generating forecast. In all cases, the Company must anticipate and plan for significant variations from the forecast and, therefore, maintain adequate reserves to balance the load.

Q. PLEASE BRIEFLY DESCRIBE GUIDEHOUSE'S CASE STUDIES.

A. In the Guidehouse study, each variation, or "case," simulates the introduction of higher and higher levels of installed solar generation supplying energy to DESC's system. In connection with the study, DESC provided Guidehouse with estimates of the amount of solar generation expected to be interconnected with its system through 2022. The scope of the study was to include varying estimates of solar generation to displace fossil-fueled and hydro generator output of 973 MW, 1073 MW, and 1,373 MW. DESC provided Guidehouse with updated information regarding the actual amount of solar generation on its system and expected to interconnect with its system pursuant to signed PPAs. Approximately 633 MW of those PPA's included the following language that contains the following VIC clause:

> *Seller shall be responsible for the payment of all charges that result from any change in any applicable law that occurs after the Effective Date that imposes new or additional (i) obligations on a Party to obtain or provide transmission service or ancillary services prior to the Delivery Point, or (ii) variable integration charges or imbalance*

> *costs, fees, penalties, or expenses, or provides benefits that, in the case of either clauses (i) or (ii), are imposed, assessed or credited by the transmission provider based on the impacts of energy generated by variable generation projects generally (collectively, the "Variable Integration Costs"). **Seller shall be responsible for all Variable Integration Costs, irrespective of whether the Variable Integration Costs are assessed against Seller or Buyer and, to the extent any Variable Integration Costs are incurred by Buyer, Seller shall promptly reimburse Buyer for such Variable Integration Costs**.*

(emphasis added).

Due to the differences in the applicability of VIC charges to individual PPAs, the base case includes the first tranche of solar installations that do not contain the VIC clause. Guidehouse then focused on a single change case with the remaining signed PPAs that contain the VIC clause. As a result, the Guidehouse study analyzed the impact of the actual amount of solar interconnected prior to 2018 separately from utility-scale solar expected to be interconnected with its system by the end of 2022. Specifically, the base case and first tranche contains 340 MW of solar generation with executed PPA's without a VIC clause and the study change case has the additional 633 MW (973 MW total) of solar generation expected to be interconnected by the end of 2021 with a VIC clause in each PPA.

Q. DID DESC REVIEW THE RESULTS OF GUIDEHOUSE'S SIMULATION?

A. Yes. Guidehouse uses a modeling software known as PROMOD®, which is a production cost model that simulates the dispatch of generating units based upon theoretical operating scenarios. These models are used to analyze electricity system costs including how system costs change when aspects of those systems change. In order to verify that Guidehouse's simulations reflected DESC's actual operating experience, the Company's Economic Resource Commitment and Resource Planning departments reviewed the baseline scenario and recommended adjustments with respect to certain operating parameters and characteristics. As a result, the PROMOD® simulations reasonably reflect the actual operating characteristics of DESC's system.

Q. HOW SHOULD THE TWO INCREMENTAL VALUES OF THE VIC BE APPLIED?

A. Guidehouse calculated the VIC for certain existing contracts and additional solar that could be added to the DESC system. These differing levels of solar penetration associated with the cumulative nameplate capacity of projects with PPAs and above existing PPAs are called tranches. It is important that the Commission and the parties recognize that additional solar capacity carries with it a higher integration cost. The VICs calculated by Guidehouse validate and quantify this progression toward higher costs.

The VIC for Tranche 1, which ranges from 340 MW to 973 MW and applies only to existing solar PPA contracts, is $1.80/MWh. This Tranche 1 VIC should be applied going forward to these existing contracts and, pursuant to Commission Order No. 2020-244, should be considered for a "true-up" against the interim VIC.

The VIC calculated for Tranche 2, which includes generation capacity of 974 MW and above, is \$3.43/MWh and will apply to the proposed PR-1 Solar rates and to additional solar only contracts under the PR-Standard Offer and PR-Form PPA.

It should be noted that Guidehouse calculated a VIC of \$4.63/MHh for a Tranche 3, which could be applied to solar generation capacity in excess of 1,073 MW.[2] In other words, the integration costs of adding more than another 100 MW (avoided cost methodology) of solar capacity to the Company's system are significantly higher than the next 100 MW. But given the pace of development, the Company is likely to exceed 1073 MW of solar before another avoided cost proceeding, in turn increasing the costs of integrating this additional solar.

The Company is not proposing to adopt a VIC of \$4.63/MWh for generation in excess of 1073 MW and proposes to apply the VIC of \$3.43/MWh (calculated for Tranche 2) for all solar generation capacity in excess of 973 MW under PR-1 Solar, PR-Standard Offer Solar, and PR-Form PPA solar contracts. This additional Guidehouse calculation is included for informational purposes only and to demonstrate the higher costs that result from additional solar penetration.

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[2] That is, if a higher VIC for Tranche 3 was implemented, the VIC for Tranche 2 would apply only to capacity between 974 MW and 1073 MW. However, as explained above, the Company is not proposing to implement a higher VIC for Tranche 3.

ADDITIONAL RESOURCES AND VIC MITIGATION

Q. WOULD THE COMPLETION OF COMBUSTION TURBINE REPLACEMENT PLAN REDUCE THE VIC?

A. Yes. DESC has filed a plan with the Commission to replace many of its aging combustion turbines ("CTs") nearing the end of their useful lives with reliable and efficient modern aeroderivative combustion turbine generators. These more efficient turbines would not only support critical needs such as black start capabilities and meeting system peak needs, but they also would reduce the VIC for existing and future solar projects. By including the replacement CTs in the production model, the VIC calculation would benefit from the same attributes that enhance system operations. Much better efficiencies allow the model to use CTs to reduce overall operating costs by displacing less efficient baseload resources. Lower forced outage rates keep more efficient units running more of the time. This absolutely results in a lower VIC calculation as well as lower operating costs in real time. These benefits have not been included in the Guidehouse PROMOD study or the DESC PLEXOS avoided cost study since the CT Replacement Plan has not been approved by the Commission.

Alternatively, with additional intermittent resources on the system, the old CTs will be called upon more and more, and will inevitably fail more frequently. As a result, the VIC will increase if no upgrades are completed for fast start assets since the higher costs and forced outage rates will be included in the production cost models. Some investment in new resources is needed to maintain the status quo which may not be adequate to ensure reliability.

It is important to note that the project costs estimated on page 28 of the Guidehouse VIC Study for the installation of combustion turbines would not be assigned to the VIC or solar generation, and the project is fully justified on the basis of the Replacement Plan. Therefore, VIC reduction is an additional benefit if the replacement plan is approved. Adding fast starting system resources that are already needed for capacity expansion, energy growth and ancillary services could also be used to assist with additional solar resources. These resources would be additional combustion turbine generators and battery energy storage systems.

Q. WOULD ADDING FAST START RESOURCES IN ADDITION TO THE CT REPLACEMENT PLAN REDUCE THE VIC?

A. Yes. DESC could add fast start resources like aero-derivative CTs and battery energy storage as part of an IRP Resource Plan, the coal plant Retirement Study, and all source competitive procurement. In these proceedings the additional CTs and storage would be approved on overall merit including reliability, cost, and CO2 reduction and still have the added benefit of reducing the VIC. The construction and operating costs would be evaluated in a system cost/benefit resource optimization, but not assigned to VIC mitigation. Reducing the VIC is a benefit of moving toward a more flexible system.

SOLAR AND TIME-OF-PRODUCTION AVOIDED COST RATES

Q. IS THE COMPANY PROPOSING AN AVOIDED COST RATE SPECIFIC TO SOLAR ELECTRIC GENERATION?

A. Yes. The Company is requesting that the Commission approve an updated rate structure for solar-only generation because this proposed rate accurately identifies the value that specific resource provides to customers and is the only rate that is subject to the VIC. This rate is presented in the proposed tariffs as Rate PR-1 Solar and Rate PR—Standard Offer Solar.

Q. WHY IS THE COMPANY PROPOSING THIS RATE ONLY FOR SOLAR ELECTRIC GENERATION?

A. Some important characteristics of a Solar-only generator are unique to this type of generation and necessitate the calculation of a rate that identifies the incremental value of those specific solar characteristics on a generating system that already operates with over 1,000 MWs of existing solar-only generation. Recognizing the known benefits and drawbacks of this type of contract is the first step to providing realistic and accurate avoided cost calculations for new solar-only generation. The benefits include no emissions and no fuel use. But this technology also has known operational limitations, including intermittency and dependency on uncontrollable factors such as cloud cover as well as the position of the sun and the time of day. PURPA obligations exacerbate some of these issues due to the must-take nature of the resource, forcing other lower variable-cost generation offline in low load situations even if it will be needed later for peak loads. Although geographic diversity provides some small relief from the intermittent nature of solar generation, it is not sufficient to offset the intermittency and variability of solar on the DESC system.

Q. CAN SOLAR GENERATION BEING DELIVERED TO THE COMPANY'S GRID BE ROUTINELY REDUCED BASED ON ECONOMICS OR LOW CUSTOMER DEMANDS?

A. No. Although normal operation for DESC generators and most generators on the grid involves dispatching and turndown, PURPA solar generally cannot be dispatched down due to the must-take contract, which contributes to an over-supply in some conditions for generally the reasons I have explained above. In fact, QF Solar facilities only reduce output at the direction of the System Operator during low load reliability events which require curtailments.

Q. HOW DO THE LIMITATIONS ON REDUCING OR CURTAILING SOLAR OUTPUT IMPACT THE VALUE OF ADDITIONAL SOLAR CAPACITY ON THE COMPANY'S SYSTEM?

A. The value of solar decreases as more is added to the system because there will be an oversupply in certain low-load conditions due to the fact that solar cannot be reduced or curtailed. Because the electric power supply always must be balanced with load in real time, firm generation must be kept online and generating for times of peak demand and times that solar is not generating. This means that additional solar generation, which has an hourly energy profile almost identical to existing solar, will have a lower value than the existing similar generator. The avoided cost methodology used here, which employs an actual solar generation profile within the production cost model, accounts for these low value hours and properly values the energy from this specific technology on the DESC system.

Q. HAS DESC CHANGED ITS USE OF TIME PERIODS FOR ITS PROPOSED AVOIDED COST RATE OFFERINGS FOR NON-SOLAR IN 2021?

A. Yes. DESC has established the Time-of-ProductionSchedule for most non-solar avoided costs rates, including an update of the Rate PR-1 time periods and the addition of 11 time periods for Rate PR-Standard Offer. The Rate PR-1 time periods are aligned with system needs and time of value but remain relatively simple with just four rate time periods. This is consistent with the needs of the smaller producer, who is less likely to alter dispatch generation hourly and might appreciate less complexity. For Rate PR-Standard Offer Non-solar, the time periods also provide avoided cost values that are aligned with system needs and times of value, but with increased definition. This increased definition that includes three or four time periods per day provides an increased opportunity for higher revenue with energy shifting.

Q. WOULD THE TOP SCHEDULES BE APPROPRIATE FOR SOLAR PRODUCERS?

A. No. The TOP Schedule, which is very well suited to non-solar and paired solar and storage technologies, is not appropriate for use with solar-only generation. This is because, as explained above, solar generation is limited in dispatchability and flexibility, and subject to intermittency and time-of-day restrictions.

Q. WHAT DOES USE OF THE TOP SCHEDULES IN THE RATE PR-STANDARD OFFER TARIFF ACCOMPLISH FOR NON-SOLAR PRODUCERS?

A. The TOP Schedules provided in the Standard Offer Tariff for non-solar properly compensate a steady, around the clock, and more traditional type generator, but also create an incentive for energy limited generators to deliver to the system in higher value hours. Using the TOP periods, the traditional generator can achieve the appropriate avoided cost energy revenue and 100% avoided capacity value by delivering energy in the winter capacity time period. Energy limited resources such as paired solar and battery energy storage facilities could also be paid 100% avoided capacity value by the timely delivery of energy when it can contribute to peak demand periods. Energy shifted to peak times will receive a credit for energy that would be higher than a single non-TOP rate by delivering energy at times of high demand to align with system needs. With this TOP Schedule, more flexible technologies, like battery storage and dispatchable generation that have a greater system benefit, can be compensated at accurate rates.

Q. HOW DID THE COMPANY IDENTIFY THE AVOIDED COST TIME PERIODS FOR THE TOP SCHEDULE?

A. DESC has included time periods for these non-solar avoided costs rates based on an analysis of the hourly marginal costs. Logical grouping of hours of the day and season by marginal cost value produced 11 time periods for PR–Standard Offer non-solar, which was simplified to four time periods for PR-1 non-solar. Since these types of resources provide around-the-clock output and/or could adjust production to enhance value, these rates reward the generator with higher revenue for generation produced in times with higher value on the DESC system. During the day, the hourly time periods with higher and lower value depend upon customer use and other factors that vary with season of the year. The study of the hourly marginal cost profile shows a sufficient difference in value to warrant three or four time periods per day depending on the season and customer usage. DESC has identified periods with similar avoided cost value by studying the hourly marginal cost, which is higher than avoided cost, but has a relative profile similar to the avoided cost profile. It is important to remember that marginal costs are by definition different from and higher than avoided costs and are not a proxy for avoided costs.

Q. SHOULD ALL SOLAR-ONLY PROJECTS BE SUBJECT TO THE VALUATION PRESENTED IN THIS APPLICATION?

A. No. A solar PPA with the flexibility to align delivery with need on the system can be compensated with rates to reflect that feature under the avoided cost methodology due to the additional attributes that allow more fully integrating the production into the Company's electric system. DESC acknowledges that contract and equipment changes can increase the value of solar generation, but not all changes can occur within the QF framework. The PURPA-based rights to put "must take" energy to the utility create the decreasing value when there is too much of the same resource. Flexible operation, however, is an advantageous method of increasing the value of a solar-only project.

The primary benefit of flexible operation is that, in hours of low load and extremely low marginal costs, a flexible solar generator could be dispatched to no output for a short period of time. Because these hours have little or no value and represent only a small percentage of all hours, and because putting energy in those hours actually increases variable costs, modeling this flexibility enhances avoided cost. Finally, pairing future projects with energy storage to move generation to non-daylight hours and high value hours as directed by the Balancing Authority Area controller increases value for customers. Planned dispatch and real-time dispatch of solar and storage as part of a system optimization creates the most capacity and energy value. Utility-owned or operated projects would have more benefit due to these capabilities.

PLEXOS MODEL USE

Q. WHY DID DESC USE THE ENERGY EXEMPLAR PLEXOS PROGRAM AS THE PRODUCTION COST MODEL FOR CALCULATING AVOIDED COST IN THIS DOCKET?

A. Although DESC has used ABB PROSYM for tasks requiring a production cost model for approximately 20 years, this software is no longer sold or supported and uses only the older dynamic linear programming algorithms. Current production cost models are often part of an optimization package of a long-term resource planning model that work closely with a short-term production cost model. The entire package normally uses the same modern solver (third-party licensed solver -- mathematical engine) for all modules. Dominion Energy's Strategic Planning Department in Richmond was already using the Energy Exemplar PLEXOS resource optimization software at the time DESC needed a replacement for PROSYM. PLEXOS was acquired by DESC at an incremental cost which is less than that for a new and complete software suite solely for DESC use. The implementation at DESC takes advantage of existing business process support for a successfully operating server application and licensing module. In Docket 2019-226-E, the 2020 IRP docket, DESC was ordered to implement long term resource optimization, and PLEXOS LT Plan/MT Plan/ST Plan meet those requirements. Along with that long-term module, PLEXOS ST Plan is purpose-built and state-of-the-art for production cost modeling which includes the avoided cost calculation. DESC has full confidence in the validity of solutions and calculations provided for this docket and plans to continue using PLEXOS for subsequent filings with the Commission until a change is needed. Through Docket No. 2019-226-E and the IRP Stakeholder Advisory Group, many of the intervening parties in both the IRP and Avoided Cost dockets are very knowledgeable about DESC's transition to PLEXOS and could be prepared for the change. Also, the DESC IRP Stakeholder Advisory group process confirmed that the updated version of PLEXOS fully meets the Commission's requirements for use in the IRP Dockets.

CONCLUSION

Q. WHAT IS DESC REQUESTING OF THE COMMISSION IN THIS PROCEEDING?

A. DESC respectfully requests that the Commission approve Rate PR-1 and Rate PR Standard Offer including the solar and TOP Schedule as applicable.

DESC also requests that the Commission approve the application of the VIC as part of the PR Rate-1 solar and PR-Standard Offer solar rates.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.